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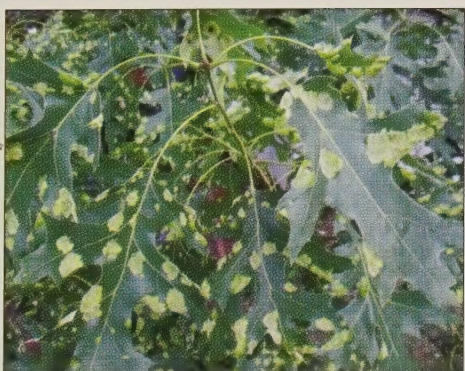


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How To

Recognize Common Diseases of Oaks in the Midwest: A Quick Guide



Forest Service
Northeastern Area
State & Private Forestry

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Top left: Anthracnose leaf symptoms

Top right: Oak wilt leaf symptoms

Middle left: Bur oak blight leaf symptoms

Middle right: Bacterial leaf scorch leaf symptoms

Bottom left: Oak leaf blister leaf symptoms

Bottom right: Botryosphaeria twig canker symptoms

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Purpose

This diagnostic guide was developed to help forestry professionals, forest woodland managers, and homeowners identify and manage the most common diseases of oak trees in Midwestern States. It discusses the most common diseases of oak, some of which can be easily confused with others. It compares and contrasts key features of each disease to help you distinguish one disease from another.

This guide provides descriptions and images of the diseases and the damage they cause. It also presents information on diagnostic features for each disease—host range, causal agent(s), symptom expression, timing and distribution within the tree, impact on tree health, pattern of tree damage on site, and general management options—in an easy-to-read table format.

This guide focuses on key diagnostic information to keep it brief and pocket sized for use in the field. It does, however, provide a link for more detailed information for each disease. In the case of bur oak blight, more detailed management recommendations are provided since this information is not published elsewhere.

Introduction

Oaks that grow in the Midwest can be organized taxonomically into two main groups based on leaf shape and other characteristics: red oaks and white oaks. Trees in both the red oak group and white oak group have fan-shaped leaves; however, red oaks have sharply pointed leaf tips while white oaks have rounded or blunt leaf tips (figure 1).

Red Oaks

A.



B.



White Oaks

C.



D.



Figure 1. Oak groups based on leaf shape.

- A. Northern red oak.
- B. Northern pin oak.
- C. White oak.
- D. Bur oak.

Bur Oak Blight (BOB)

Host Range	Affects only <i>Quercus macrocarpa</i> var. <i>oliviformis</i> , the small-acorn variety of bur oak.
Causal Agent	Fungus: <i>Tubakia iowensis</i>
Symptoms	<p>Leaf symptoms: Small, black spots develop on leaf veins; expand outward from the veins; and produce large, brown, wedge-shaped dead areas (lesions) on the leaf. Entire leaves may turn brown and appear scorched. Figure 2 shows the full range of leaf symptoms. Some leaf petioles become infected, turn brown, and die; black pustules form on the base of infected petioles (figure 3).</p> <p>Leaf drop: Yes. Some premature leaf drop is typical in late summer. Some leaves with infected petioles remain on the tree throughout the winter.</p> <p>Sapwood discoloration: No.</p>
Symptom Distribution within Tree	<p>Bottom up, inside out.</p> <p>Lower, inner portions of branches show leaf symptoms first (figure 4). Later symptoms spread upward and outward within the crown.</p>
Timing of Symptoms Within Tree	Mid to late summer. Large, wedged-shaped lesions are evident. Symptoms may continue to spread during late summer and fall if rainy weather persists.
Impact on Tree Health	Symptoms develop late in the season. Disease progression within the tree is slow. Not a serious threat to overall tree health, unless repeated defoliations lead to tree stress and trigger decline and/or invasion by secondary invaders such as the twolined chestnut borer and Armillaria root disease.
Pattern of Tree Damage on Site	Random and scattered. Some trees may be severely affected while neighboring trees appear healthy. This is likely due to variation in the resistance of individual bur oak trees to this disease.
Management Options	See options 2, 5, and 9 in table 1 on page 21 and page 22.
More Information	<p>See page 22.</p> <p>http://na.fs.fed.us/pubs/palerts/bur_oak_blight/bob_print.pdf (Accessed August 2017)</p>



Figure 2. Full range of leaf symptoms: dark veins; large, wedge-shaped lesions; and totally brown leaves.



Figure 3. Black, pimple-like pustules (see arrows) form on infected leaf petioles in late summer and fall.



Figure 4. Leaf symptoms first appear on lower branches and then progress upward in the tree's crown.

Anthracnose

Host Range	Affects both red and white oaks, but is more common on white oak.
Causal Agent	Fungus: <i>Apiognomonina quercina</i> (asexual stage: <i>Discula</i> spp.)
Symptoms	<p>Leaf symptoms: Individual and localized brown leaf spots develop anywhere on the leaves and are not restricted to leaf margins (figure 5). Leaf spots expand and often coalesce into large, brown blotches that have a papery texture (figure 6). Leaves may also become curled or distorted. Figure 7 shows the full range of leaf symptoms.</p> <p>Compare to: Oak wilt and bacterial leaf scorch, which have browning of leaf tissue on the leaf tips and margins only and do not produce individual and localized leaf spots in the center of leaves.</p> <p>Leaf drop: Yes. Common in the lower portions of the crown where the disease is most severe.</p> <p>Sapwood discoloration: No</p>
Symptom Distribution within Tree	<p>Bottom up, inside out.</p> <p>Lower, inner portions of branches show leaf spot/blotch symptoms first. Later symptoms spread upward and outward within the crown.</p>
Timing of Symptoms Within Tree	Spring and early summer, following periods of high rainfall in the spring. Symptoms may continue to spread during summer and fall if rainy weather persists.
Impact on Tree Health	Not a serious threat to overall tree health, unless repeated defoliations lead to tree stress and trigger tree decline and/or invasion by secondary invaders such as twolined chestnut borer and Armillaria root disease.
Pattern of Tree Damage on Site	Often widespread, particularly after periods of high rainfall in the spring.
Management Options	See options 2, 3, 5, and 9 in table 1 on page 21.
More Information	http://extension.psu.edu/pests/plant-diseases/all-fact-sheets/anthracnose-on-shade-trees (Accessed August 2017)



Figure 5. Brown leaf spots develop anywhere on a leaf and are not restricted to the leaf tips or margins.



Figure 6. Leaf spots may expand into large, brown blotches that often have a papery texture.



Figure 7. Full range of leaf symptoms: small leaf spots in the center of the leaf and large, brown blotches that may encompass large portions of the leaf surface.

Oak Leaf Blister

Host Range	Affects both red and white oaks, but is more common and severe on red oaks.
Causal Agent	Fungus: <i>Taphrina caerulescens</i>
Symptoms	<p>Leaf symptoms: Blister-like areas develop on the upper leaf surface. The blisters are round, raised, and wrinkled (figure 8). They vary in color, first appearing yellowish (figure 9), then turning white, and later becoming brown to blackish (figure 10).</p> <p>Leaf drop: Some defoliation may occur if leaf infections are severe.</p> <p>Sapwood discoloration: No.</p>
Symptom Distribution within Tree	<p>Bottom up, inside out.</p> <p>Lower, inner portions of branches show leaf spot/blister symptoms first. Later symptoms spread upward and outward within the crown.</p>
Timing of Symptoms Within Tree	<p>Spring and early summer, following periods of high rainfall in the spring.</p> <p>May spread during summer and fall if rainy weather persists.</p>
Impact on Tree Health	Heavy infections may be unsightly, but they do not endanger the health of a tree.
Pattern of Tree Damage on Site	Often widespread, particularly after periods of high rainfall in spring and in sites that have poor air circulation.
Management Options	See options 2,3, and 8 in table 1 on page 21.
More Information	http://plantclinic.cornell.edu/factsheets/oakleafblister.pdf (Accessed August 2017)



Figure 8. On the upper leaf surface, blisters are round and raised.



Figure 9. Blisters first appear yellowish.



Figure 10. Blisters later turn brown to blackish (see arrows).

Botryosphaeria Twig Canker

Host Range	Affects both red and white oaks.
Causal Agent	Fungus: <i>Botryosphaeria</i> spp. (asexual stage: <i>Diplodia</i> spp.)
Symptoms	<p>Leaf symptoms: Brown, wilted leaves on the tips of branches (figure 11).</p> <p>Dieback typically extends only 4 to 6 inches inward from the branch tips. Dark brown (almost black), elongated lesions (cankers) develop on affected branches (figure 12). Cankers injure the phloem and cambium tissue, impair the flow of water and nutrients, and induce the leaves beyond the cankers to turn brown and wilt.</p> <p>Black, pimple-like fruiting structures develop within the cankers (figure 13).</p> <p>Compare to: Twig pruner insects or cicada damage, which can cause similar branch tip dieback symptoms.</p> <p>Leaf drop: Typically not; however, minor leaf drop has been occasionally reported.</p> <p>Sapwood discoloration: Yes. Associated with cankers.</p>
Symptom Distribution within Tree	Random and scattered within the tree. Only the outermost tips of branches are affected, not the whole branch, as is typical of oak wilt and bacterial leaf scorch.
Timing of Symptoms Within Tree	Mid-summer. Dead branch tips remain visible through the fall.
Impact on Tree Health	Minimal damage to the overall health of the tree. Cankers usually remain localized in small branches, resulting in dieback to branch tips only.
Pattern of Tree Damage on Site	Often widespread, particularly after periods of high rainfall in spring.
Management Options	See options 2, 4, and 8 in table 1 on page 21.
More Information	http://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/450/450-726/450-726_pdf.pdf (Accessed August 2017)



Figure 11. Red oak displaying brown, wilted leaves on the tips of branches.



Figure 12. Dark brown, elongated canker (see area between arrows) on an affected branch tip.



Figure 13. Black, pimple-like fruiting structures (see arrows) form on affected branches in late summer and fall.

Oak Wilt	
Host Range	Affects both red and white oaks, but is more common and severe on red oaks.
Causal Agent	Fungus: <i>Ceratocystis fagacearum</i> (asexual stage: <i>Chalara quercina</i>)
Symptoms	<p>Leaf symptoms: Leaf browning starts at leaf tips and margins and progresses inward toward the midrib (figure 14). The fungus invades the xylem vessels; impairs flow of water to the leaves; and induces symptoms of marginal watersoaking, leaf browning or bronzing (scorch), and wilting.</p> <p>Compare to: Bacterial leaf scorch where a dull brown or yellow halo is evident between scorched tissue and healthy, green leaf tissue.</p> <p>Leaf drop: Yes. Often very rapid and extensive on red oaks. Many leaves on the ground may be green or only partially wilted. White and bur oaks experience less leaf drop.</p> <p>Sapwood discoloration: Yes. Typically present and appears as gray-brown to black discoloration in the outer annual ring of sapwood (figure 15). Sapwood discoloration may sometimes be hard to see in red oaks.</p>
Symptom Distribution within Tree	<p>Top down, outside in.</p> <p>Upper, outermost tips of branches scorch and wilt first (figure 16). Soon after, symptoms can progress down the branches.</p>
Timing of Symptoms Within Tree	Usually mid to late summer; can progress throughout the summer.
Impact on Tree Health	<p>Red oaks: fatal and fast moving (< 3 weeks).</p> <p>White oaks: fatal, but slower moving (1–5 years).</p>
Pattern of Tree Damage on Site	<p>Expanding pockets (root graft spread) or isolated trees (overland spread by sap feeding beetles).</p> <p>New infections may be associated with tree wounding.</p>
Management Options	See options 6, 7, and 9 in table 1 on page 21.
More Information	http://na.fs.fed.us/pubs/howtos/ht_oakwilt/identify_prevent_and_control_oak_wilt_print.pdf (Accessed August 2017)



Figure 14. Red oak leaves displaying the full range of oak wilt symptoms: marginal leaf scorch that progresses uniformly inward toward the midrib.



Figure 15. Infected red oak branch segment, with bark removed, to show dark discoloration in the sapwood. Left: Cross-sectional view showing discoloration in the outer ring of sapwood. Right: Longitudinal view showing dark streaks in sapwood.



Figure 16. Bur oak exhibiting brown, wilted leaves on scattered branches. The wilting started at the tips of branches and progressed down the branches.

Bacterial Leaf Scorch (BLS)

Host Range	Affects both red and white oaks; most common on pin and red oak.
Causal Agent	Bacterium: <i>Xylella fastidiosa</i>
Symptoms	<p>Leaf symptoms: Pronounced red-brown discoloration (scorch), starting at leaf tips and margins and progressing inward to midrib. On red oak, a yellow halo is present between the scorched tissue and healthy green tissue (figure 17). On northern pin oak, the yellow halo may be absent and is replaced by a dull brown band that borders the scorched tissue (figure 18).</p> <p>The bacterium invades the xylem vessels, impairs the flow of water to the leaves, and induces symptoms of marginal leaf scorch.</p> <p>Compare to: Oak wilt, where the marginal leaf scorch pattern is more uniform vs. the often irregular and undulating pattern of BLS.</p> <p>Leaf drop: Yes. Typically occurs one month earlier than normal leaf drop in the fall.</p> <p>Sapwood discoloration: No.</p>
Symptom Distribution within Tree	Starts with one or two scattered branches and spreads slowly to other branches within the crown each successive year of infection (figure 19). Most, if not all, leaves on an affected branch will show symptoms.
Timing of Symptoms Within Tree	Mid to late summer and into early fall.
Impact on Tree Health	Disease progression is slow. May take 5–10 years before major branch dieback occurs. Eventually the disease may be fatal.
Pattern of Tree Damage on Site	Random and scattered. Some trees may be severely affected while neighboring trees appear healthy.
Management Options	See options 1 and 2 in table 1 on page 21.
More Information	http://www.usna.usda.gov/Research/BacterialLeafScorch.html (Accessed August 2017)



Figure 17. Red oak displaying the pronounced yellow halo between the brown, scorched tissue and green, healthy tissue.



Figure 18. Northern pin oak displaying symptoms that are not as striking as those in red oak. The yellow halo is often not present, and only a dull brown band borders the scorched tissue.



Figure 19. Initially a single branch develops symptoms. Symptoms recur each year, with an increase in the number of branches affected.

Oak Decline (Part 1)

Host Range	Affects all red and white oaks.
Causal Agent	Complex of long-term abiotic stress factors (climate, age, and site predisposition) combined with short-term stresses (defoliation, drought, flooding, and frost damage); often followed by invasion by opportunistic insects and fungi such as the twolined chestnut borer (<i>Agrilus bilineatus</i>), Armillaria root disease (<i>Armillaria</i> spp.), and red oak borer (<i>Enaphalodes rufulus</i>).
Symptoms: General Overview	<p>Leaf symptoms: Red-brown uniform discoloration (scorch) of leaves; scorch symptoms can occur suddenly.</p> <p>Small, upper-crown branches exhibit leaf symptoms first and begin to die back. Large branches and entire sections of the crown may die over time. Dieback proceeds from the top of the crown downward and creates a "stag-head" effect where large antler-like branches (with no leaves) stick up in the top of the tree's crown. Red to brown, scorched leaves are often present in a transition zone between the leafless tips of branches and the base of branches where green, healthy leaves are present (figure 20). Under extreme stress conditions, the entire tree crown may exhibit brown, scorched leaves in one growing season.</p> <p>Foliage may occur in clusters or tufts as a result of buds sprouting on branches and the trunk (figure 21). Some leaves may fail to develop in the spring or wilt shortly after bud break; others may appear chlorotic (yellow) or small.</p> <p>Leaf drop: No. Dead, scorched leaves are often retained a bit later than usual leaf drop in the fall, especially if twolined chestnut borer is present.</p> <p>Sapwood discoloration: No.</p>
Symptoms: If twolined chestnut borer is present	Insect tunneling in symptomatic branches and/or the trunk, just beneath the bark (figure 22).



Figure 20. This tree shows the dead-brown-green pattern of crown symptoms: dead branch tips (stag-head); brown, discolored leaves in the transition zone; and green, healthy leaves at the base of affected branches and on lower branches.



Figure 21. Oak tree exhibiting tufted foliage growth on branches and the main trunk.



Figure 22. When you remove the bark on affected branches or the main trunk, meandering tunnels (galleries) are evident on the surface of the sapwood.

Oak Decline (Part 2)

Symptoms: If twolined chestnut borer is present (cont.)	<p>Larvae, the immature stage of the insect, construct winding galleries of sufficient depth to impair the flow of water to the leaves, and induce symptoms of marginal leaf browning, scorch, and wilt (figure 23).</p> <p>Emerging adults (figure 24) produce D-shaped exit holes (figure 25).</p> <p>Dead, brown leaves usually remain attached to the tree a bit later than normal in the fall.</p>
Symptoms: If Armillaria root disease is present	<p>White mycelial fans (figure 26) and shoestring-like rhizomorphs (figure 27) grow between the bark and wood at the root collar and on roots. The fungus eventually girdles the root collar and large buttress roots and impairs the flow of water within the tree.</p> <p>In the autumn, clusters of honey-colored mushrooms may form at the base of infected trees (figure 28).</p>
Symptom Distribution within Tree	<p>Top down, outside in.</p> <p>Upper, outermost tips of branches are affected first. Larger branches, whole sectors of the crown, or the entire tree may later die.</p>
Timing of Symptoms Within Tree	<p>Variable. Trees invaded by twolined chestnut borers generally exhibit the first visible symptoms of leaf scorch in mid to late summer.</p>
Impact on Tree Health	<p>Usually the progression of decline/dieback is slow, occurring over several years. However, progression of decline may be faster and result in tree death if large numbers of twolined chestnut borers attack the tree, Armillaria root disease is severe, or other stress factors are also present.</p>
Pattern of Tree Damage on Site	<p>Random and scattered. Often associated with site features such as ridge tops and wet areas where stress factors such as drought, defoliation, flooding, and frost damage occur.</p>
Management Options	<p>See options 2 and 5 in table 1 on page 21.</p>
More Information	<p>http://www.na.fs.fed.us/spfo/pubs/fidls/oakdecline/oakdecline.htm (Accessed August 2017)</p>



Figure 23. Larvae of the twolined chestnut borer are white, slender, about 1 inch long when fully grown, and have two spines at the tip of the abdomen.



Figure 24. Adults are slender, black beetles that are $\frac{1}{8}$ to $\frac{1}{2}$ inch long with two golden stripes along the back.



Figure 25. Emerging adult beetles produce characteristic D-shaped exit holes (arrow).

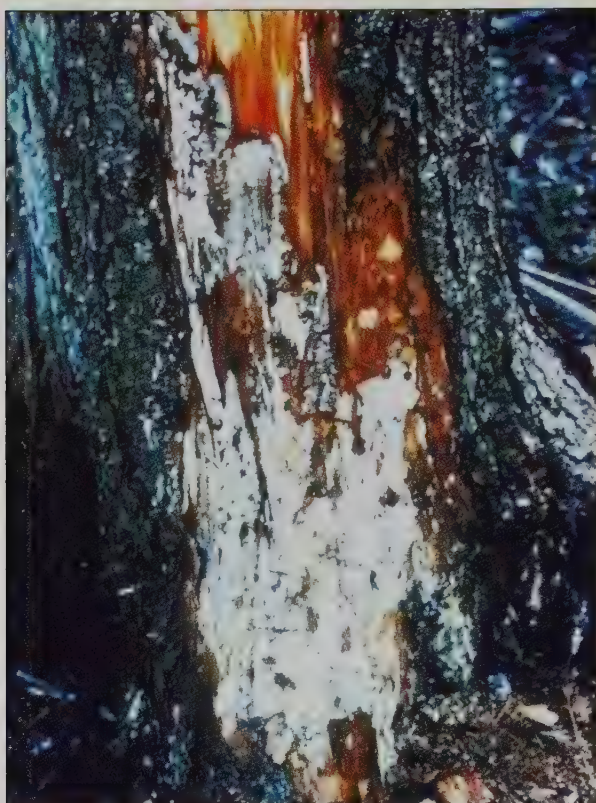


Figure 26. A white layer of fungal growth (mycelial fan) develops between the bark and the wood at the base of the tree. Some mycelial fans will glow in the dark.



Figure 27. Dark, shoestring-like structures (rhizomorphs) form on the base of the tree and grow just under the bark.



Figure 28. In the fall, the Armillaria fungus produces clusters of honey-colored mushrooms at the base of some infected trees.

Table 1. Management Options

1. There is no known cure, prevention strategy, or therapy.
2. Carry out cultural practices that promote the vigor of individual trees and stands (groups of trees being similarly managed):

For Homeowners

- Properly mulch trees, irrigate during dry periods, and fertilize if soil testing results indicate the need.

For Forest Land Managers

- Promote and develop trees with large, healthy crowns.
 - Diversify age classes; do not allow old-age trees to dominant the stand.
 - Avoid thinning in a stand when trees are under severe stress from drought or during an insect outbreak. Any disturbance will open up the stand to drying winds and cause additional stress to residual trees.
 - Carry out silvicultural practices that encourage species best adapted to the site.
3. Rake fallen infected leaves and destroy.
 4. Prune infected twigs and small branches and destroy. Prune in the winter when trees are dormant.
 5. Prune deadwood and destroy. Prune in the winter when trees are dormant.
 6. Avoid wounding or pruning oaks during the peak infection period—April, May, and June.
 7. Prevent overland spread by removing infected trees in a timely fashion and properly treating wood. Prevent underground spread by severing root grafts with a vibratory plow or rupturing the roots.
 8. Chemical controls are not typically warranted.
 9. Treat high-value trees with a registered fungicide if tree health is endangered.

Management Recommendations for Bur Oak Blight (BOB)

The extent to which BOB damages the health of bur oak trees is not yet fully known. Because leaf damage and defoliation occur late in the season, BOB typically does not cause outright tree death; however, repeated and severe leaf damage and defoliation can stress trees and open them to attack by secondary invaders such as two-lined chestnut borer and *Armillaria* root disease. BOB, working in concert with these secondary invaders, can cause tree death. To date, many high-value landscape and park trees have experienced defoliation for 10 or more years and are severely stressed. These trees are prime candidates for the use of a fungicide treatment program aimed at reducing disease severity. The key to successfully managing BOB is to treat trees with a fungicide before they are severely stressed and before they become invaded by two-lined chestnut borers.

The fungicide propaconazole, injected at the rate of 10-15 ml per inch of d.b.h., has significantly reduced symptom development in trees for 3 or more years. To be effective, the fungicide should be applied in early spring as soon as the leaves are fully expanded. If applied later, the fungicide will not effectively reduce the primary infections and will not sufficiently lower the disease level. In forest stands, the current management alternatives are limited to removal of highly impacted trees.

Trees should not be re-treated until leaf symptoms again reach moderate disease levels. Since BOB is a slow-progressing disease, moderate leaf symptoms should not recur for several years. Raking up infected leaves will have little impact on reducing the occurrence of this disease because the fungus overwinters at the base of infected leaf petioles, most of which remain on the tree over the winter.

The good news is that not all bur oak trees are equally susceptible to BOB. In fact, within a stand, park, or yard landscape, some trees may be severely infected while adjacent trees appear healthy.

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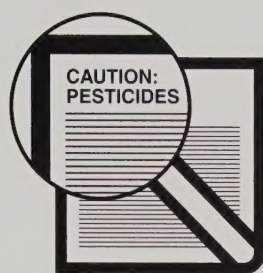
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Pesticide Precautionary Statement

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.



Store pesticides in original containers under lock and key—out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

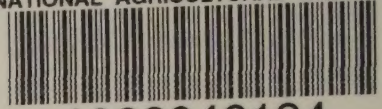
Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.



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